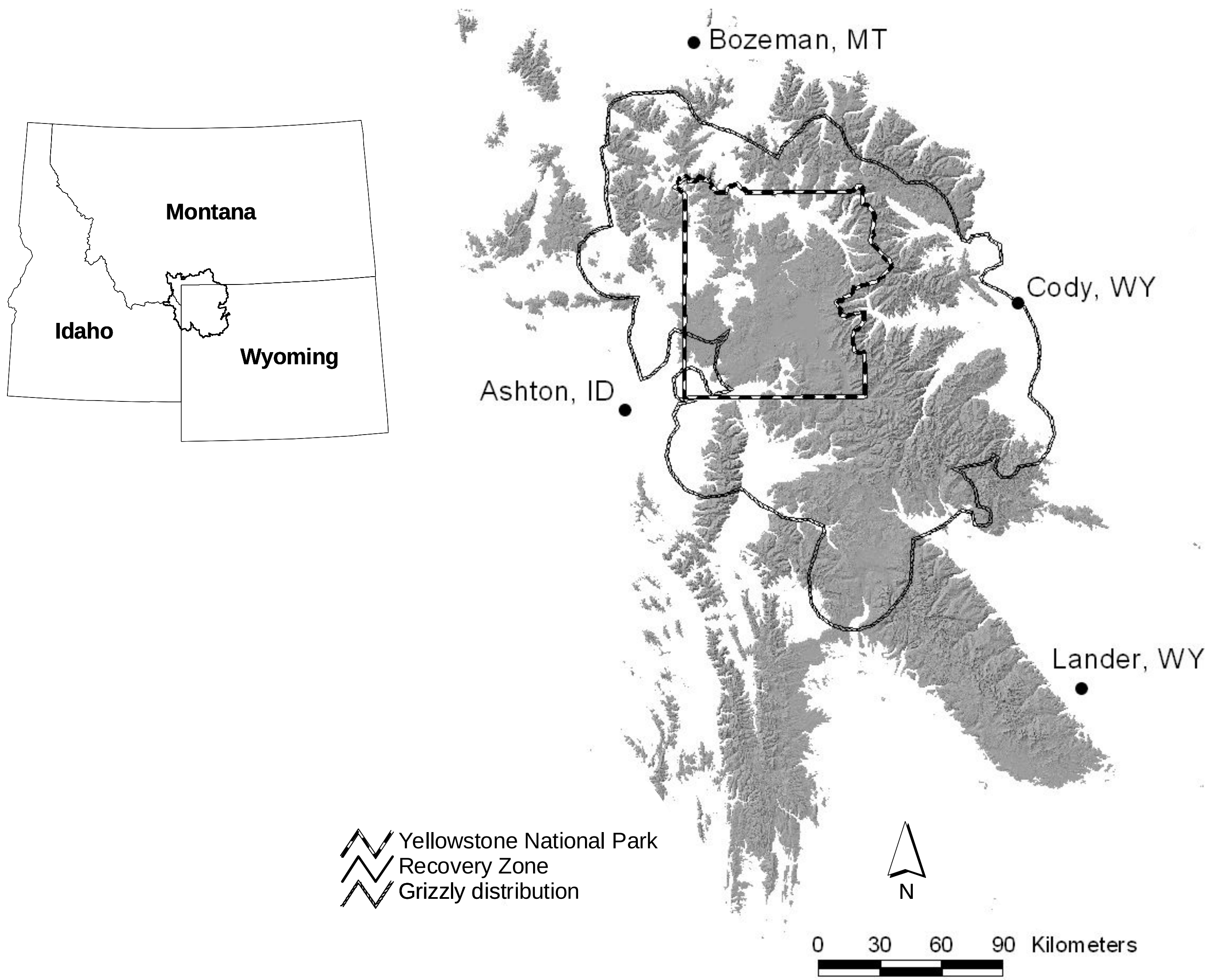
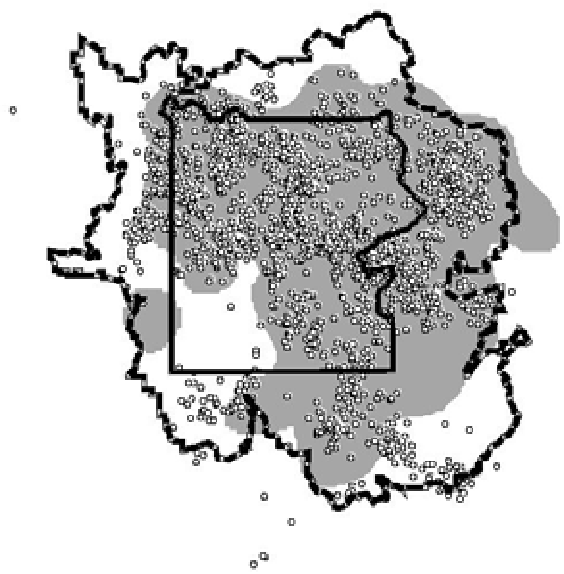


Figure 1. Study area in Montana, Wyoming, and Idaho, USA. Inner polygon is the boundary for Yellowstone National Park, outer boundary is the current estimate for occupied grizzly bear range (Schwartz et al. 2002) in the Greater Yellowstone Ecosystem. Shading indicates area with elevation above 2,350 meters. The Grizzly Bear Recovery Zone is depicted on the map on the left.

(a)



(b)

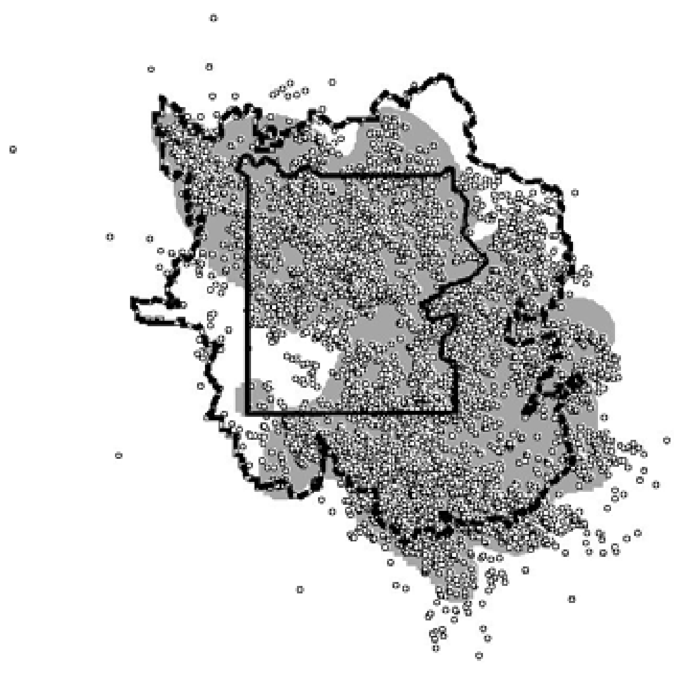


Figure 2. Distribution of our telemetry sample for grizzly bears in the Greater Yellowstone Ecosystem during the 1980s (a) and 1990s (b). Shaded area represents the estimated distribution of unique sightings of unduplicated females with cubs during the 1980s (Blanchard et al. 1992) and 1990s (Schwartz et al. 2002). Small circles represent telemetry locations, the solid line represents the boundary of Yellowstone National Park, and the dashed line details the Grizzly Bear Recovery Zone.

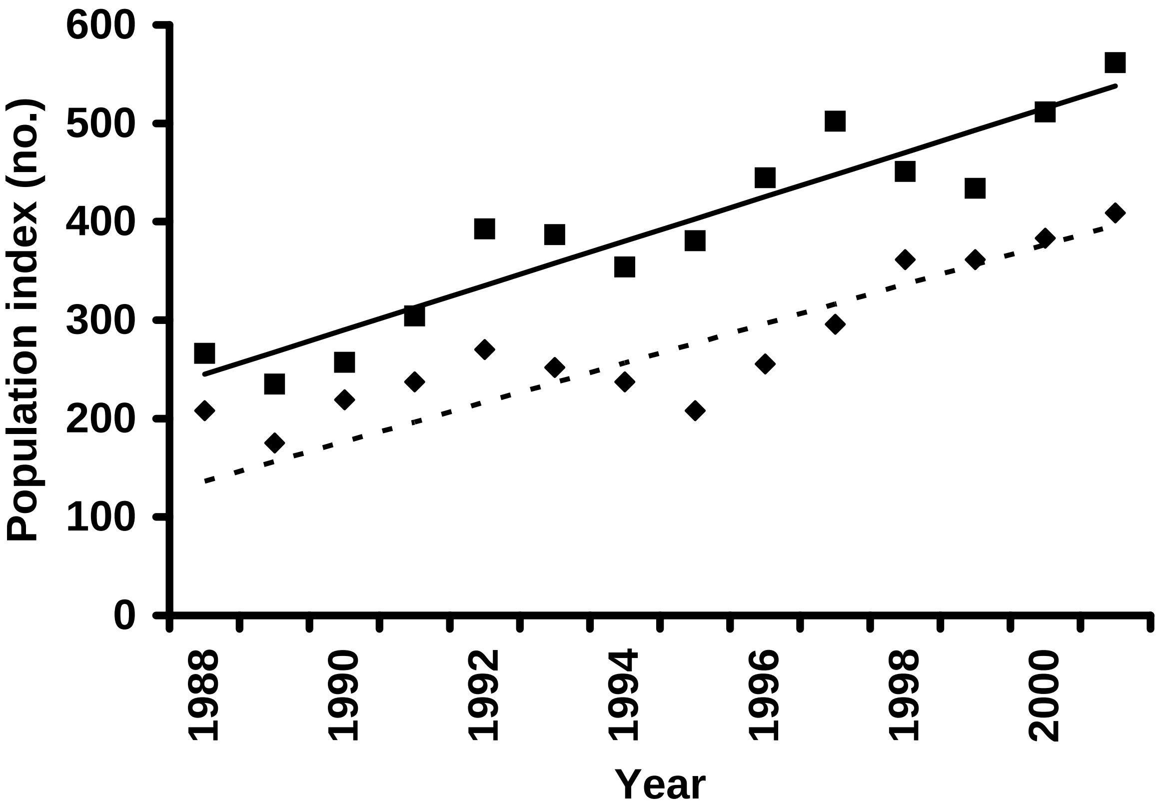


Figure 3. Indices of population abundance for grizzly bears in the Greater Yellowstone Ecosystem, 1988–2001. Indices were generated from annual counts of unduplicated female grizzly bears with cubs-of-the-year summed over 3 years and divided by 0.274. The diamonds are raw counts and squares are adjusted counts using a second-order sample coverage estimator (Keating et al. 2002). The dashed line is a least squares fit to the raw data with a Cochrane-Orcutt adjustment to accommodate first-order autocorrelation. The solid line is a least square fit to the adjusted counts; no adjustment for autocorrelation was needed.

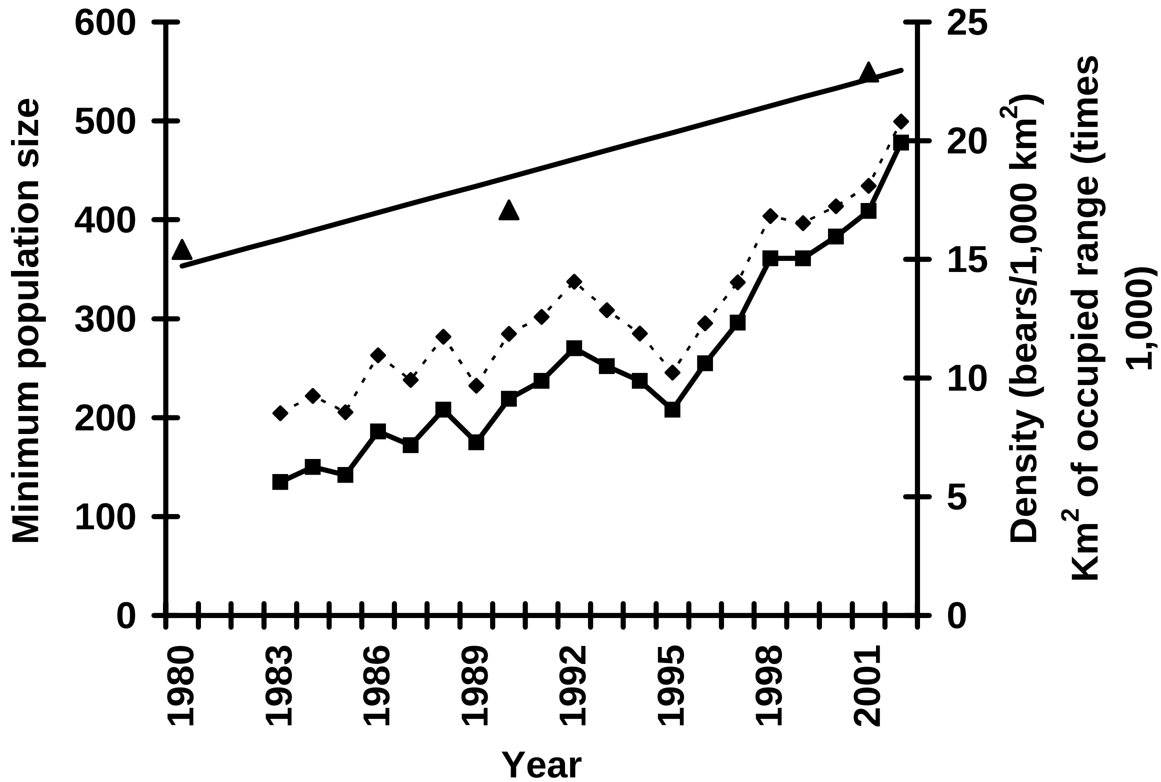


Figure 4. Comparison between the unadjusted minimum counts of female grizzly bears with cubs summed over 3 years and divided by 0.274 (solid line with squares) and estimated density (dashed line with diamonds) for the Greater Yellowstone Ecosystem. The three triangles represent estimates of range occupancy for the 1970s, 1980s, and 1990s. The line is a linear fit to the data. Annual range occupied was derived from this line and divided into the annual estimate of minimum populations size to generate the density estimate.

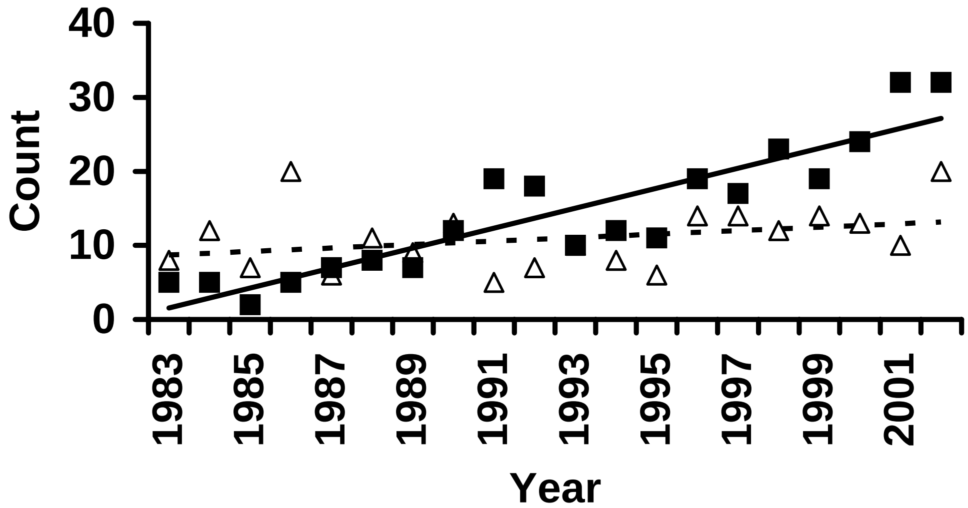


Figure 5. Counts of unique female grizzly bears with cubs-of -the year from 1983–2002 inside Yellowstone National Park (YNP) (open diamonds) and outside YNP (solid squares). The slope of the fitted line inside YNP (dashed line) was not different from zero (*P* = 0.16), whereas the slope for counts outside YNP (solid line) was significantly different from zero (*P* ≤ 0.001). The Durbin-Wattson statistics indicated no autocorrelation.

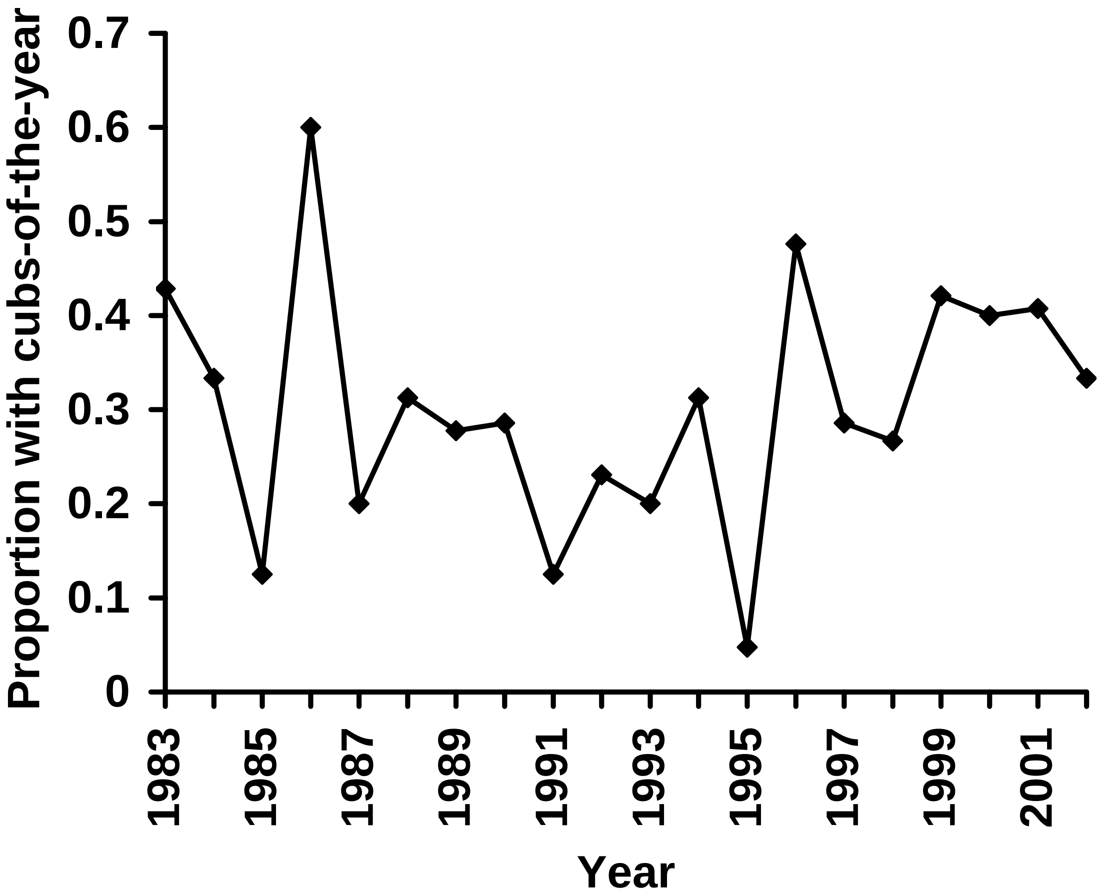


Figure 6. Proportion of radiocollared adult female grizzly bears (>3 years old) with cubs-of-the year in the Greater Yellowstone Ecosystem, 1983–2002.

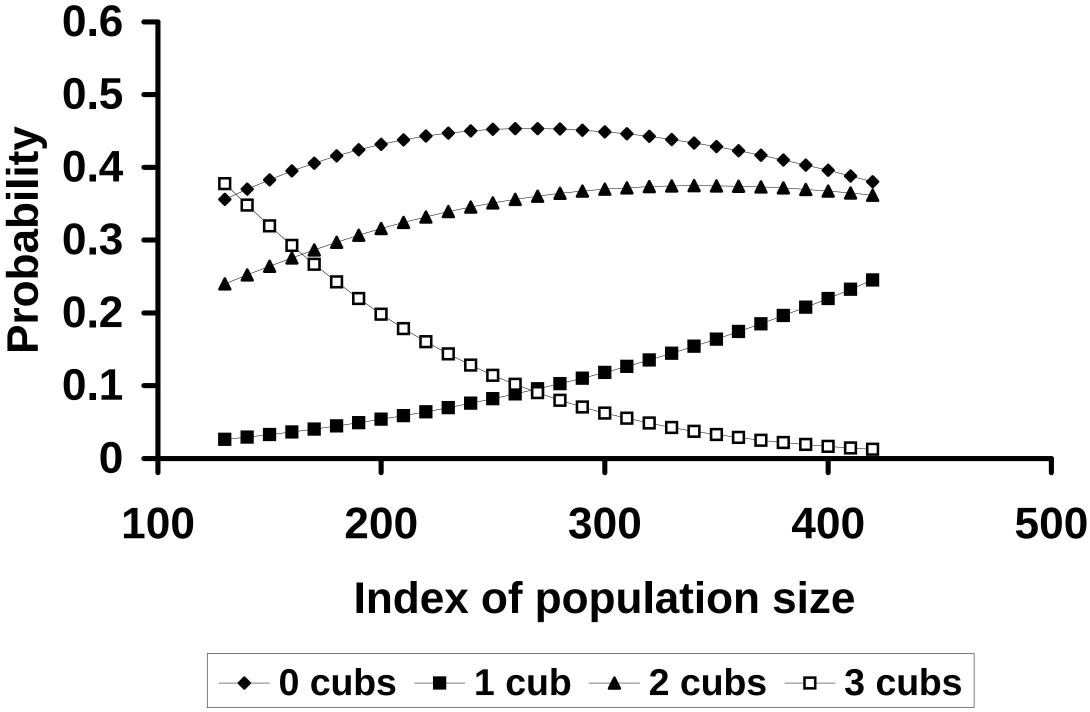
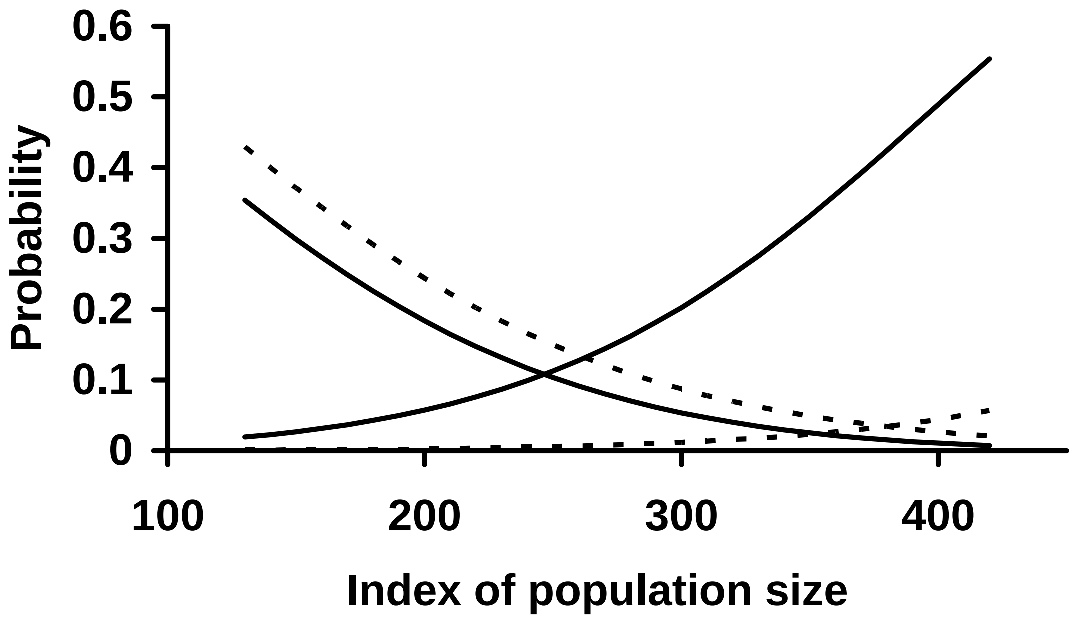


Figure 7. Estimated probability of an available breeding-age female (≥3 years) grizzly bear producing a litter of 0-, 1-, 2-, or 3-cubs as a function of population size in the Greater Yellowstone Ecosystem, 1983–2002.

(a)



(b)

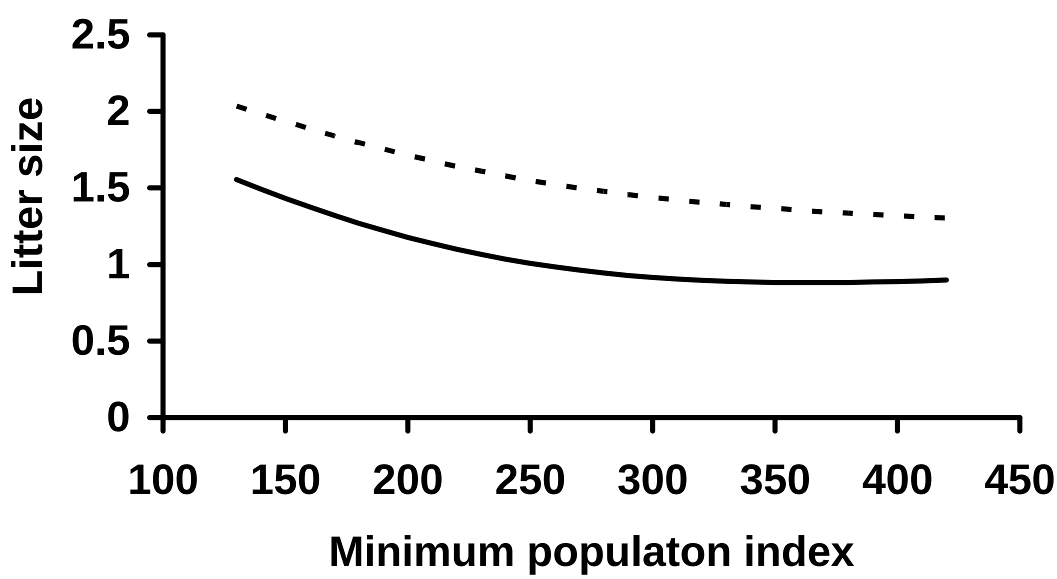


Figure 8. (a) Estimated probability of an adult female grizzly bear available to breed and the production of a 1- (increasing function) or 3-cub litter (decreasing function) as a function of population size and low (0, solid line) and high (29, dashed line) counts of whitebark pine cones in the Greater Yellowstone Ecosystem, 1983–2002. (b) Estimated mean litter size derived by combining the 4 equations for litter size 0 to 3 cubs from Figure 7 for low (0) and high (29) counts of whitebark pine cones. Litter size does not equal that observed in the field because females not producing a litter (zero cubs) are included.

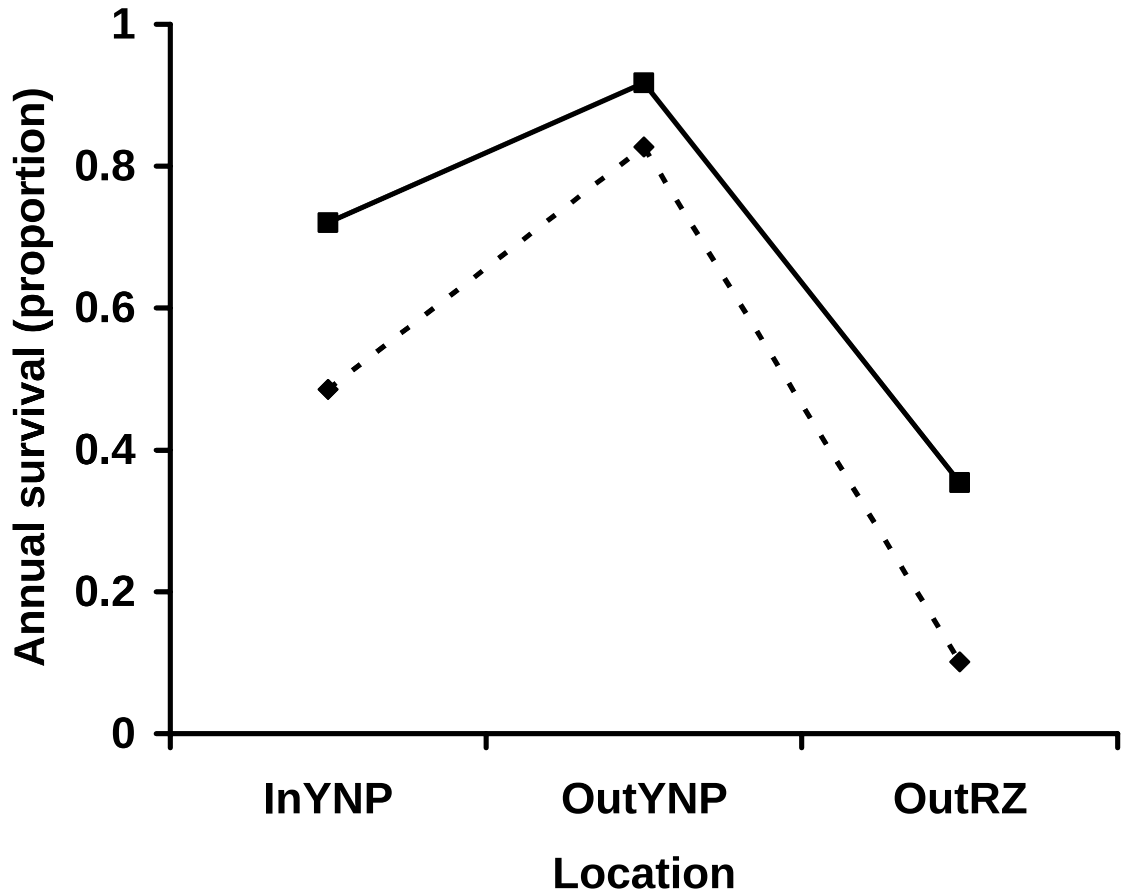


Figure 9. Annual survival of cub (dashed line) and yearling (solid line) grizzly bears in the Greater Yellowstone Ecosystem, 1983–2001. Residency influenced survival. The ecosystem was divided into 3 zones, inside Yellowstone National Park (InYNP), inside the Grizzly Bear Recovery Zone (RZ) but outside YNP (OutYNP), and outside the RZ (OutRZ).

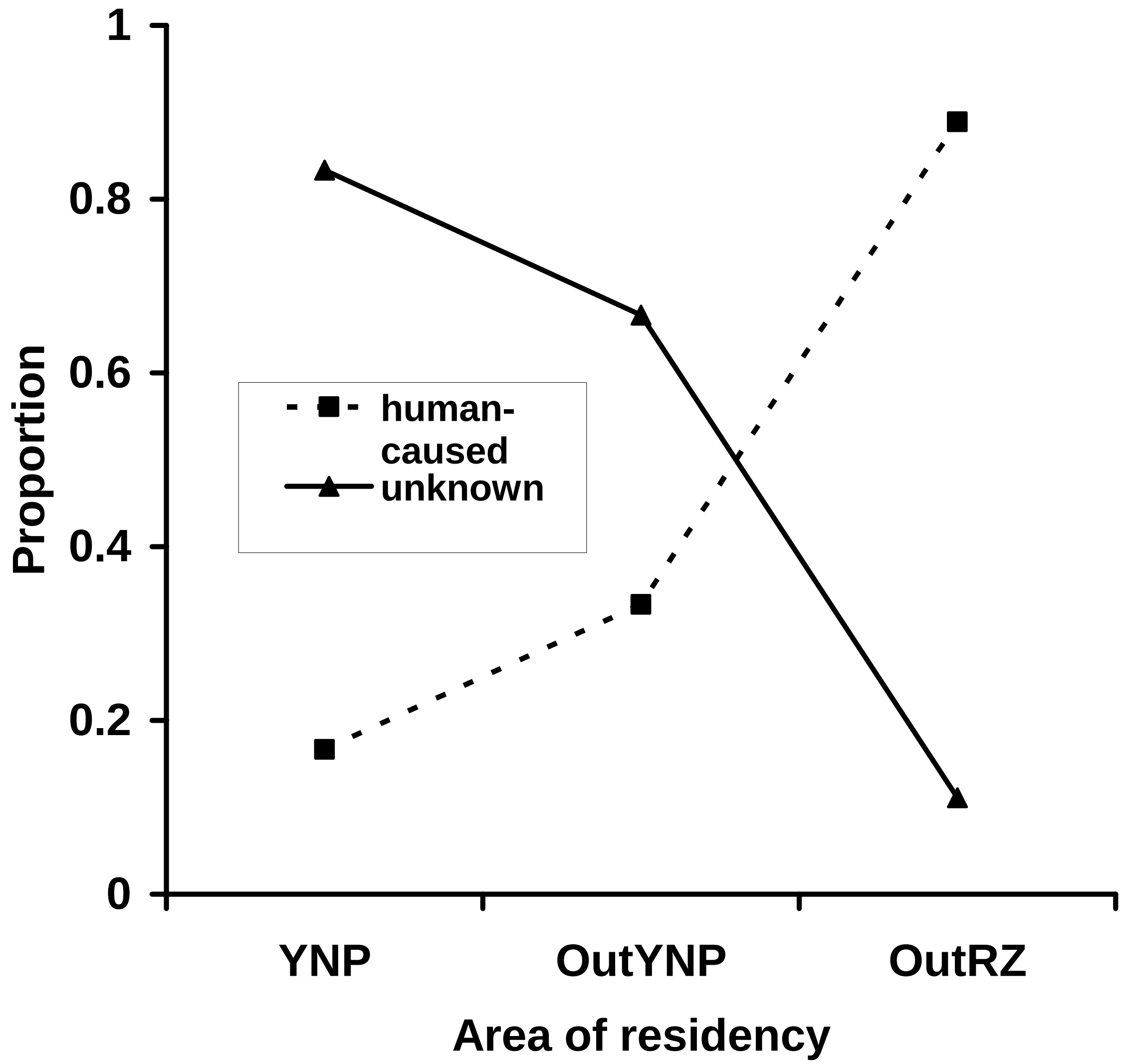


Figure 10. Proportion of cub and yearling grizzly bear mortality caused by humans and from unknown causes in 3 zones of residency within the Greater Yellowstone Ecosystem, 1983–2001. Zones are inside Yellowstone National Park (InYNP), inside the Grizzly Bear Recovery Zone (RZ) but outside YNP (OutYNP), and outside the Recovery Zone (OutRZ).

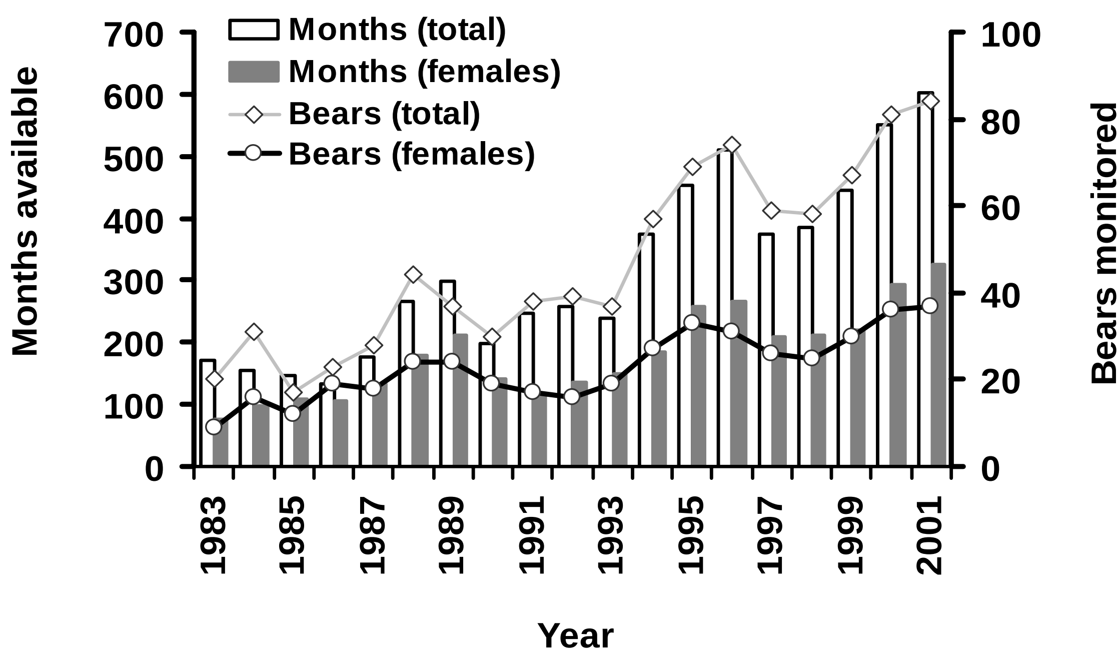


Figure 11. Monthly availability and sample size for all grizzly bears monitored in the Greater Yellowstone Ecosystem, 1983–2001. Female sample size and availability are for the study sample only.

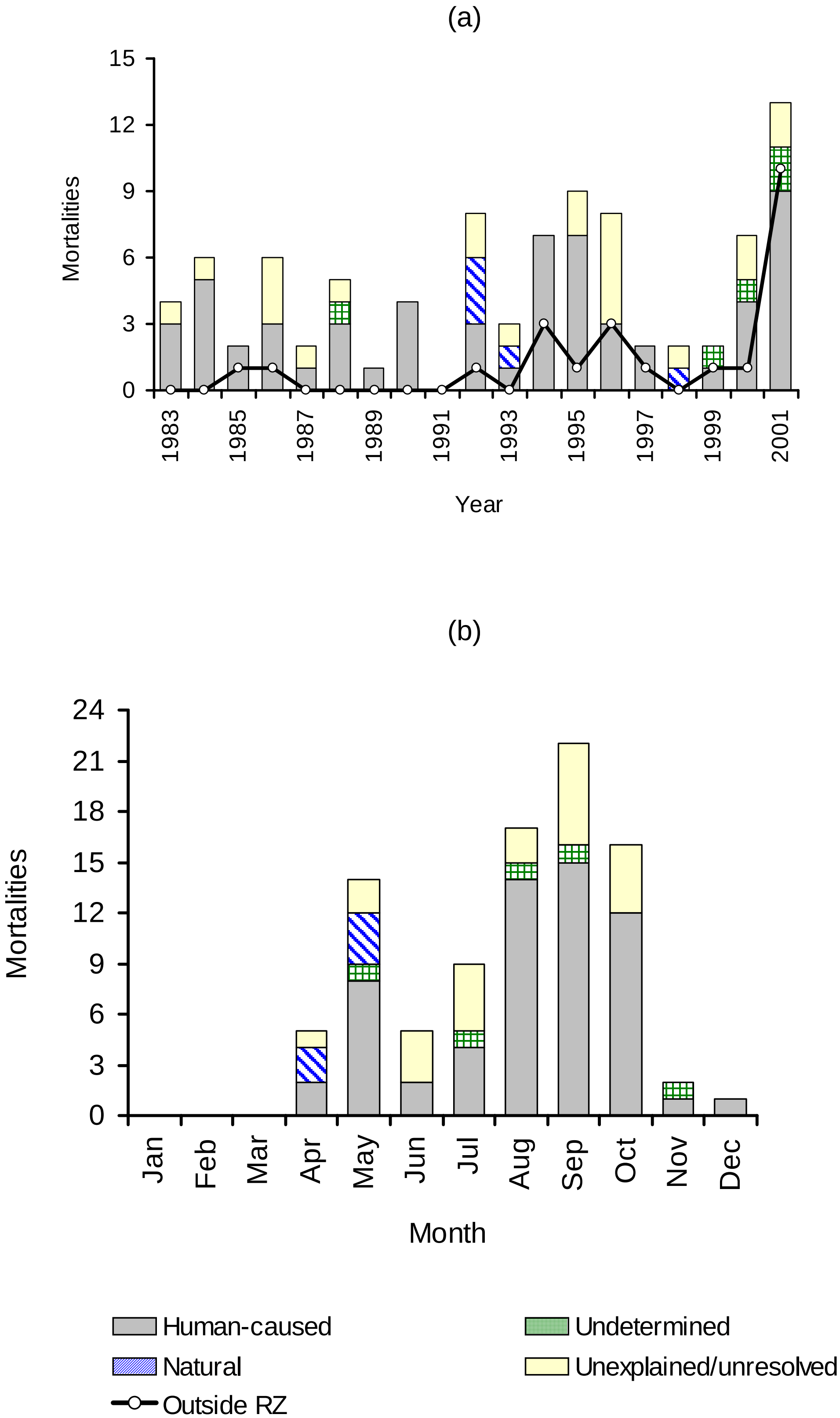


Figure 12. Annual (a) and monthly (b) mortalities of grizzly bears documented by cause in the Greater Yellowstone Ecosystem, 1983–2001. Numbers of known mortalities outside the Grizzly Bear Recovery Zone (RZ) are also shown.

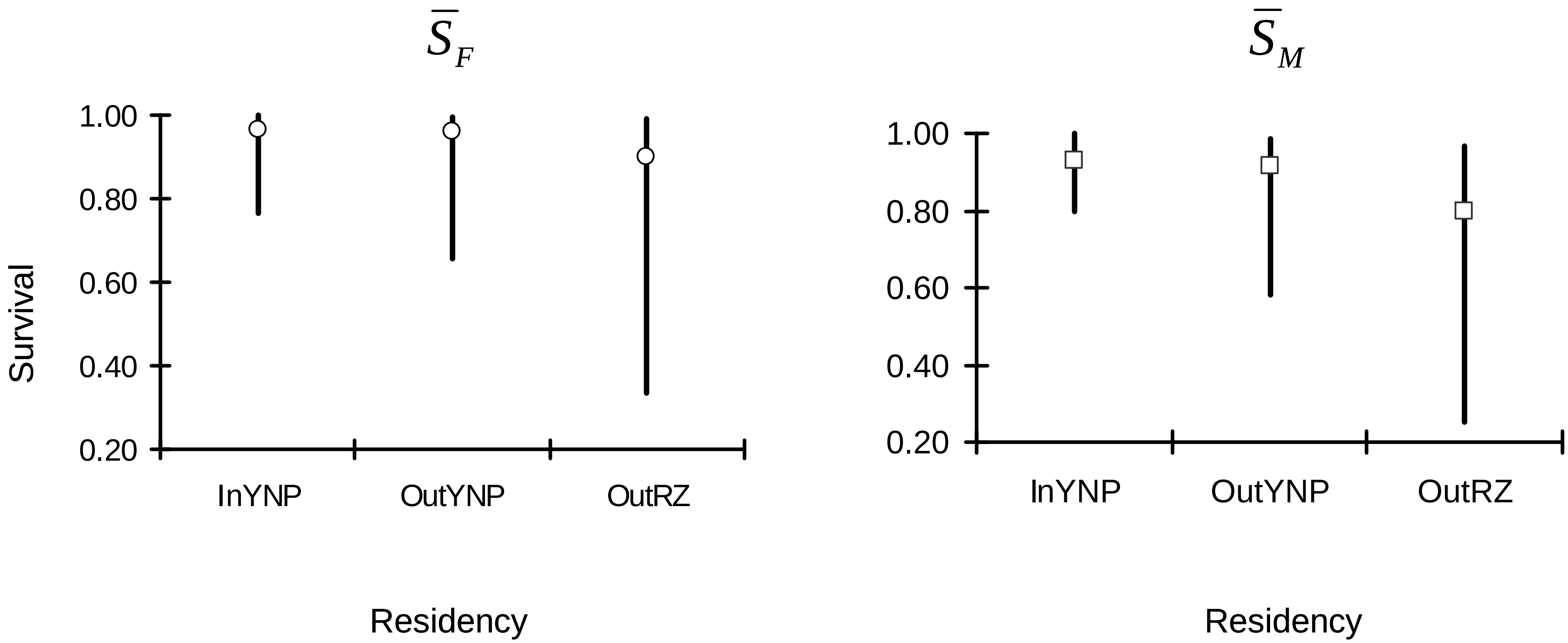


Figure 13. Effect of location on estimates of annual survival for female (*F*) and male (*M*) study sample grizzly bears in the Greater Yellowstone Ecosystem, 1983–2001. Estimates and 95% CI were computed using β's and SE from the best model (Table 16) produced from the censored data set and the average whitebark pine cone counts (WBP = 7.5) for the period. Locations were inside Yellowstone National Park (InYNP), inside the Grizzly Bear Recovery Zone (RZ) but outside YNP (OutYNP), and outside the RZ (OutRZ).

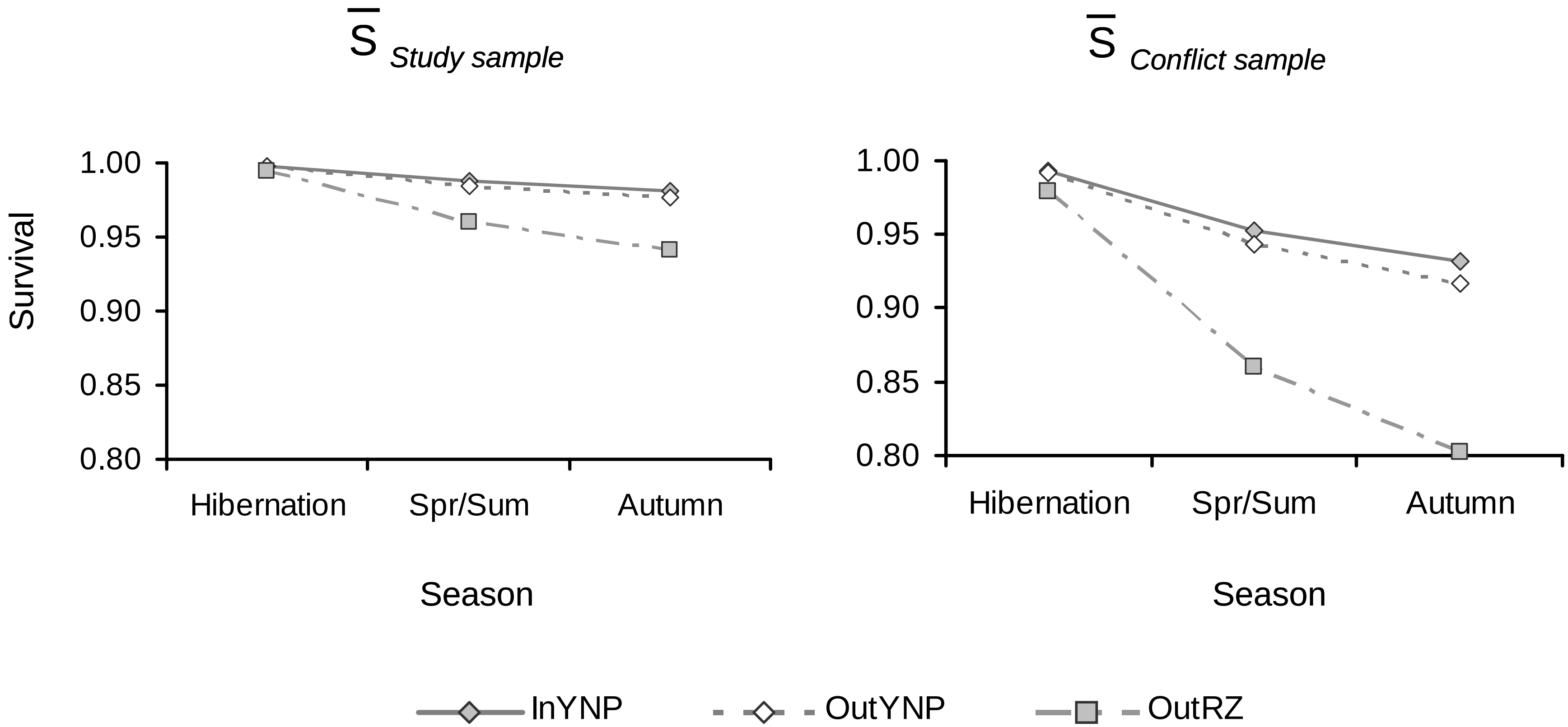


Figure 14. Female grizzly bear survival estimates for study sample and conflict sample under average whitebark pine cone production (WBP = 7.5) and varying residency in the Greater Yellowstone Ecosystem, 1983–2001. Estimates were computed using β's from the top model (Table 16) produced from the censored data set. Residency was inside Yellowstone National Park (InYNP), inside the Grizzly Bear Recovery Zone (RZ) but outside YNP (OutYNP), and outside the RZ (OutRZ). Season were Hibernation (Nov, Dec, Jan, Feb, Mar), Spr/Sum (Apr, May, Jun, Jul), and Autumn (Aug, Sep, Oct).

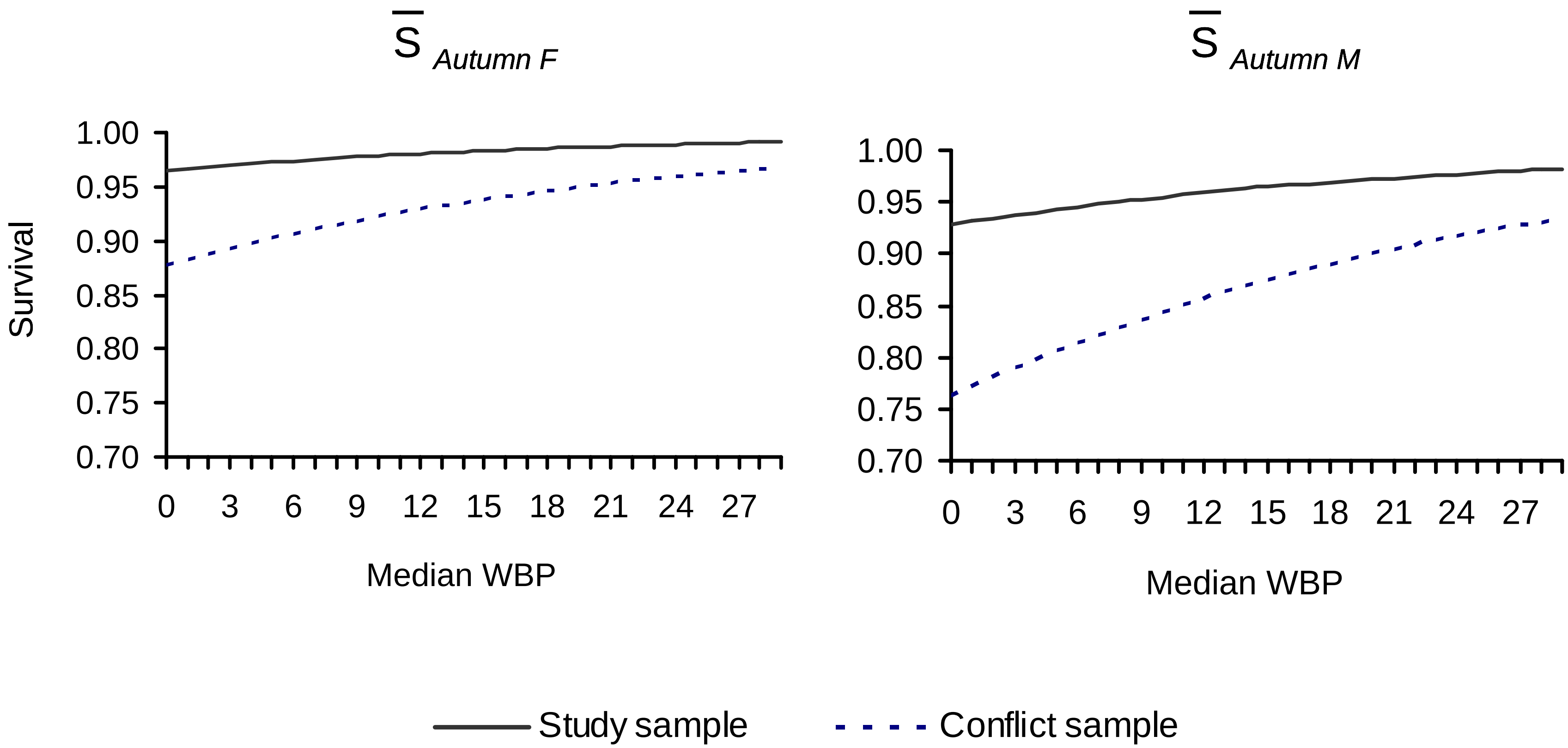


Figure 15. Influence of whitebark pine cone production on autumn survival rates for female (*F*) and male (*M*) grizzly bears in the Greater Yellowstone Ecosystem, 1983–2001. Estimates were computed using β's from the best model (Table 16) produced from the censored data set and average residency covariates.

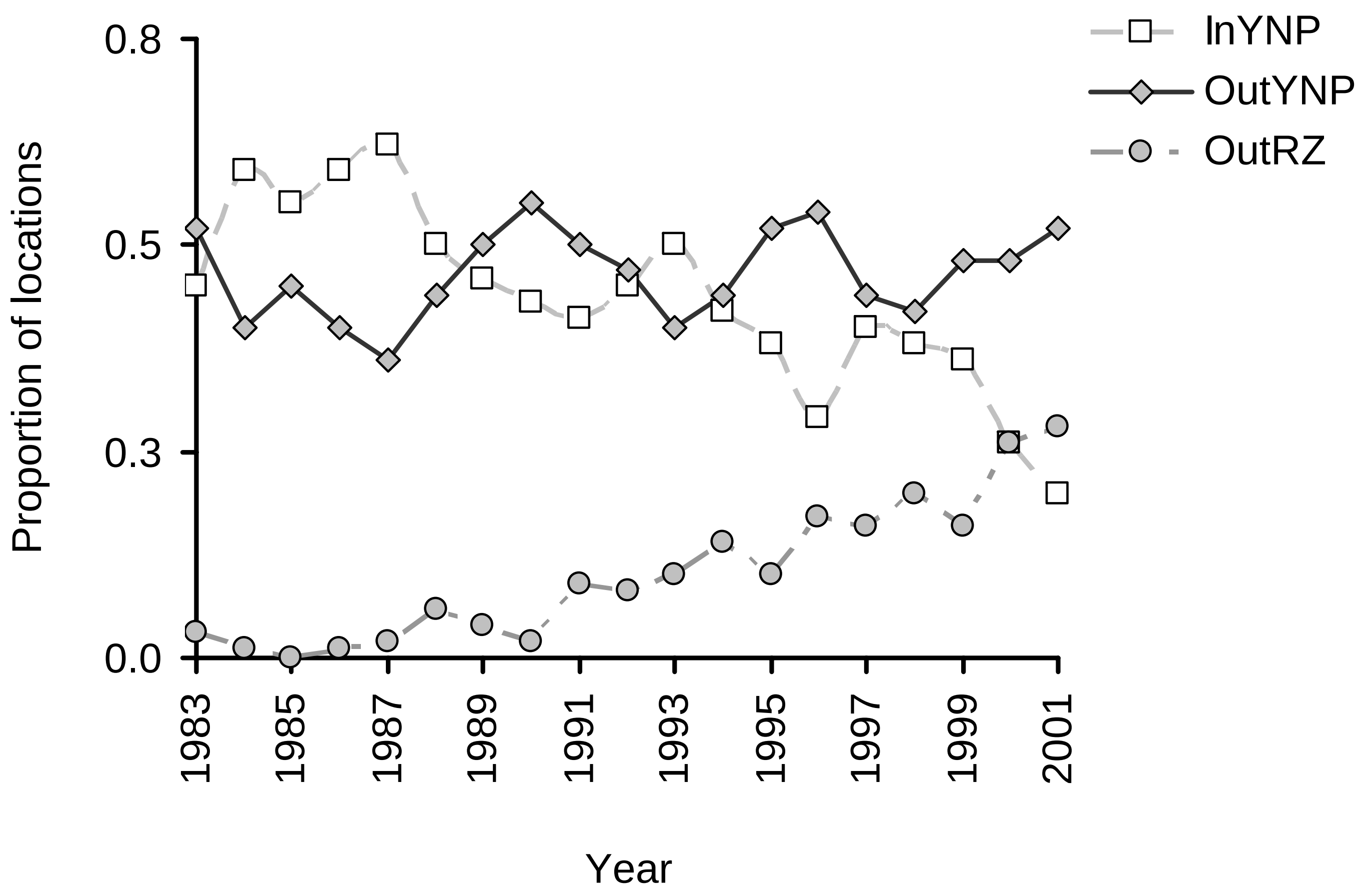


Figure 16. Average annual proportion of locations of instrumented grizzly bears inside Yellowstone National Park (InYNP), inside the Grizzly Bear Recovery Zone (RZ) but outside YNP (OutYNP), and outside the RZ (OutRZ), 1983–2001.

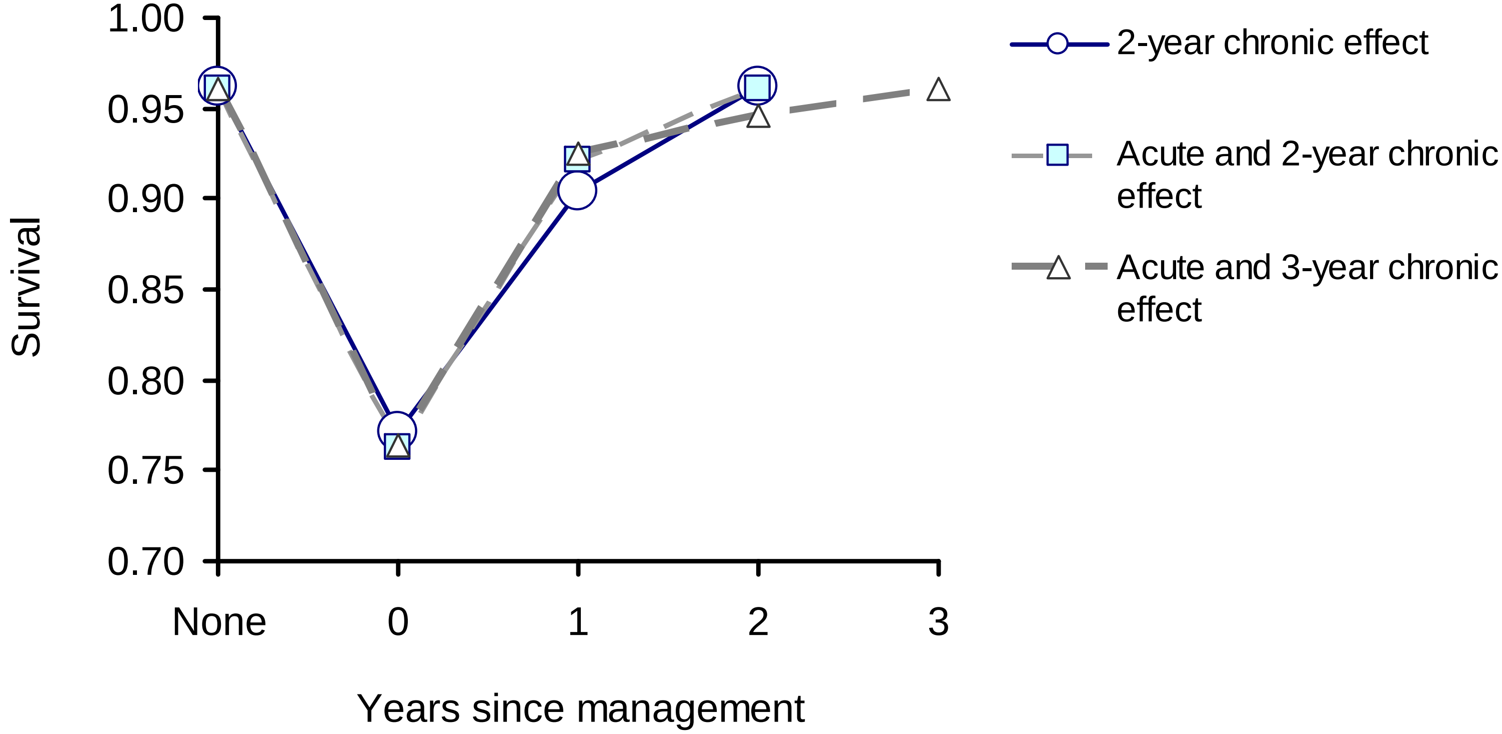


Figure 17. Comparison between annual survival of independent female grizzly bears never captured in a conflict setting and years since management capture (0 = acute, 1–3 = chronic) for bears with a conflict history in the Greater Yellowstone Ecosystem, 1983–2001.

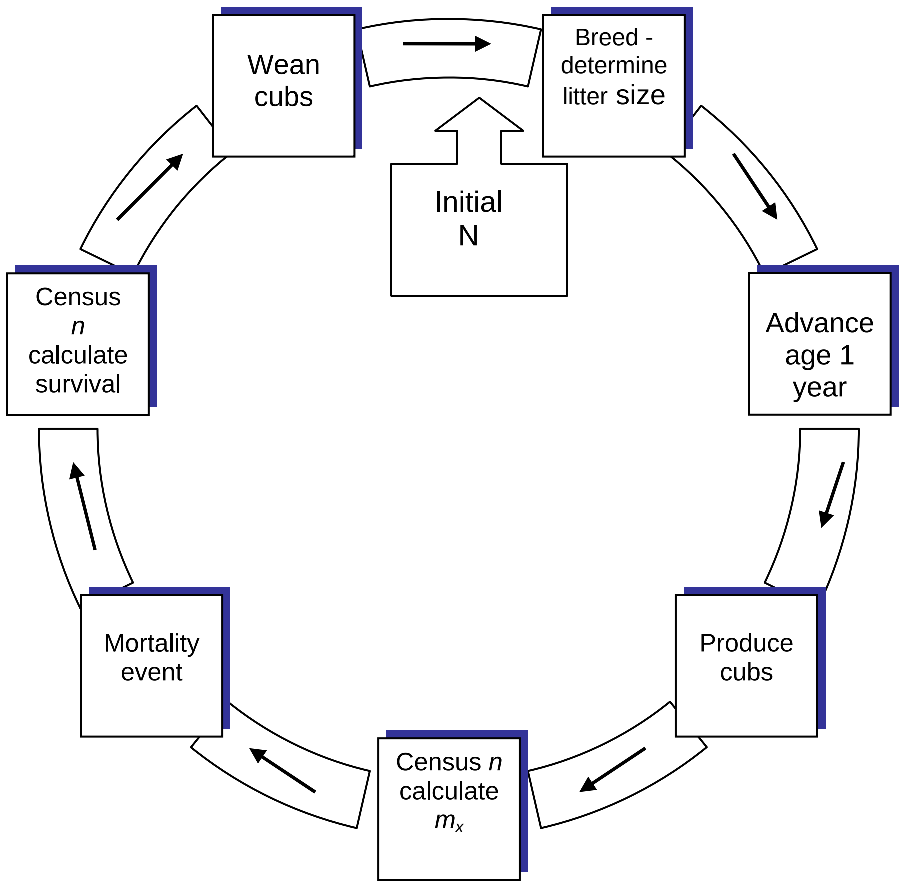


Figure 18. Schematic diagram showing annual life-history events modeled in the stochastic simulation of the grizzly bear population.

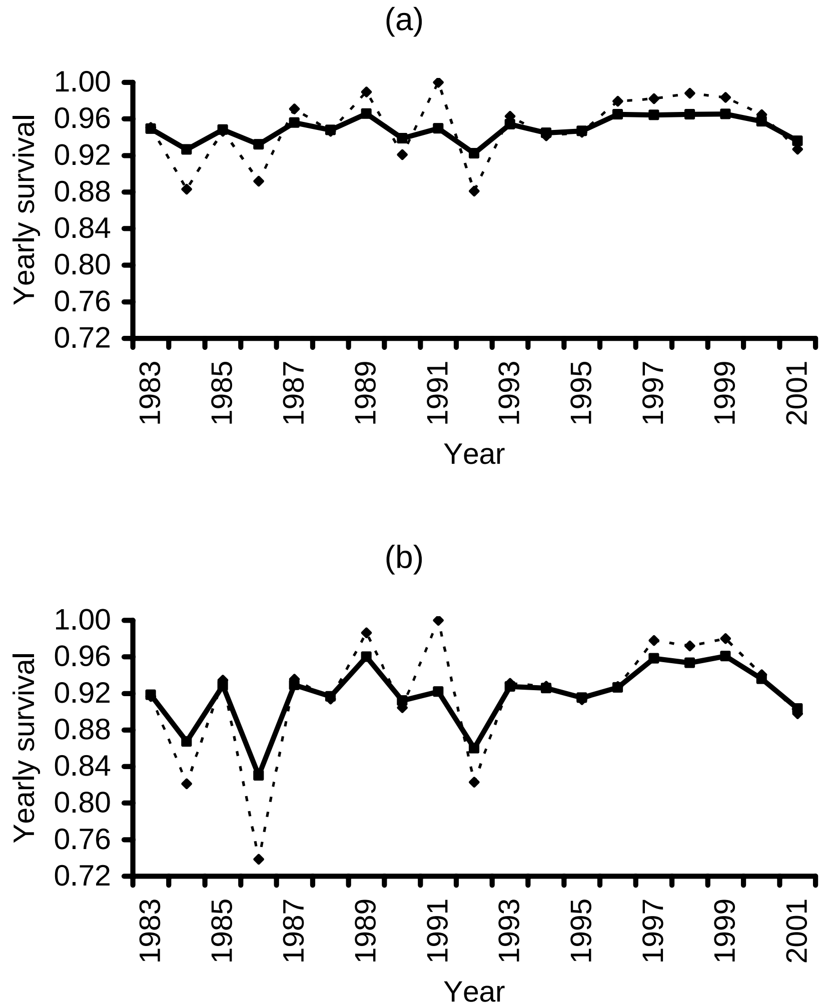


Figure 19. Yearly estimates of independent female survival in the Greater Yellowstone Ecosystem grizzly bear population, 1983–2001, showing raw estimates, which include sampling variation (dotted line), and shrinkage estimates, which exclude sampling variation (solid line). Bears with unresolved fates were censored (a) or assumed to have died (b).

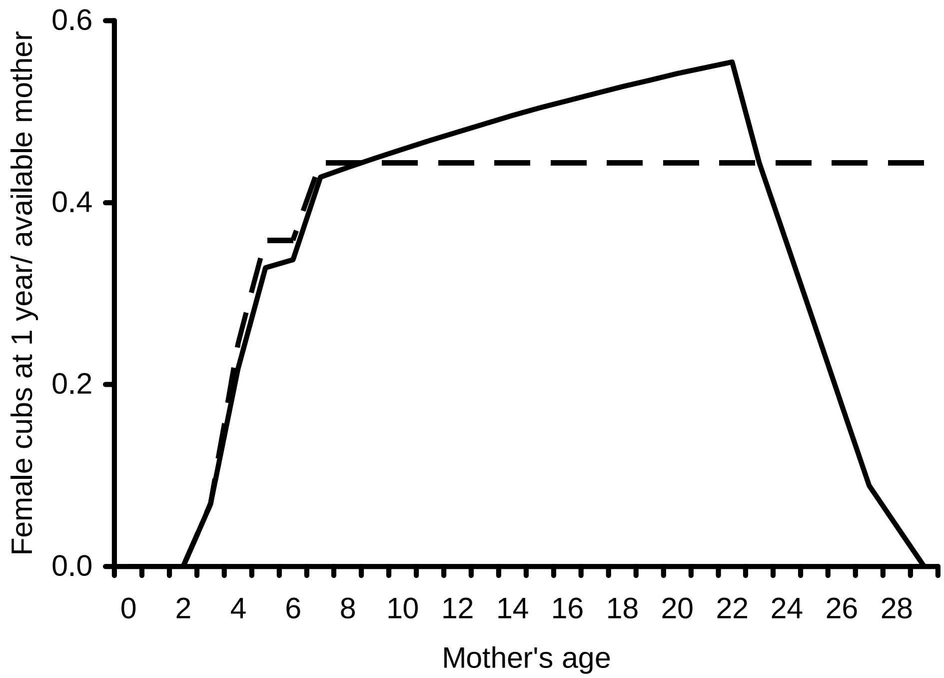


Figure 20. Reproductive output for grizzly bears by age of mother as modeled in the stochastic simulations. Basic projections used a flat function (dashed line), in which production of litters by females unaccompanied by young remained constant once females reached the age of 7 years. In sensitivity analyses, we simulated reproductive output with an alternative function relating reproductive output to mother's age, which combined increasing survival of cubs with age of mother through age 21 years (Schwartz et al. 2005*a*) with reproductive senescence at approximately age 27 years (Schwartz et al. 2003*b*).

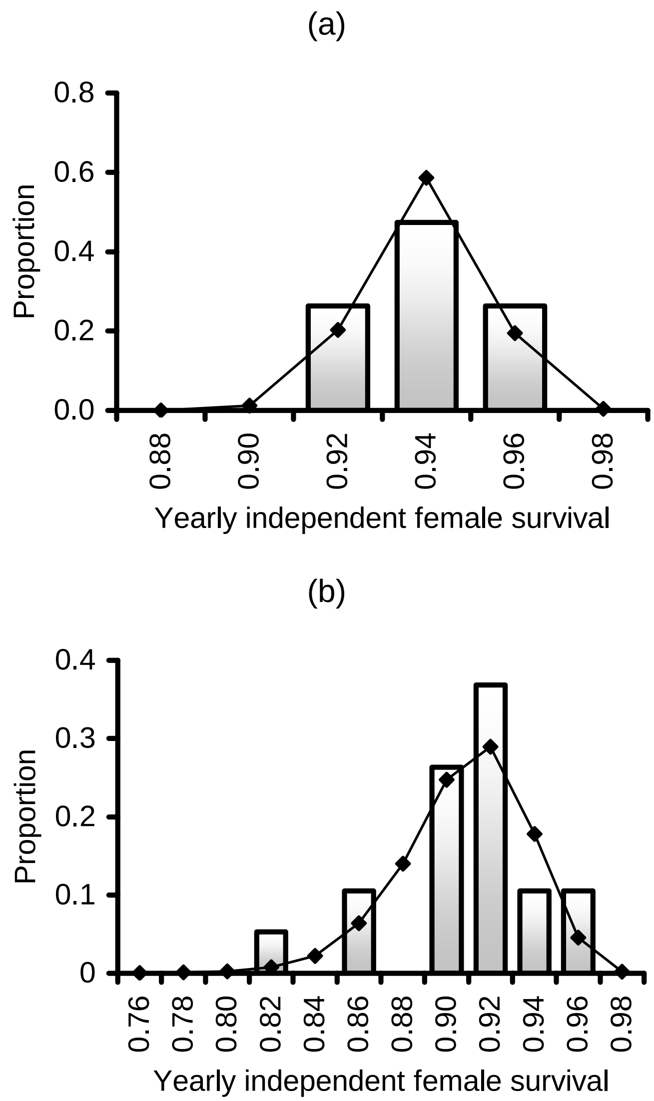


Figure 21. Examples of distribution of yearly independent survival rates for female grizzly bears, comparing simulations with data from the Greater Yellowstone Ecosystem (GYE), 1983–2001. Bars are proportion of years in GYE (*n* = 19) with various survival rates. Lines are proportion of simulation years (*n* = 30,000) in various survival rate categories. In panel a, all unresolved bears were treated as censored with simulations of low yearly process variance, whereas results in panel b were calculated assuming that all unresolved bears died combined with simulations of high yearly process variance.

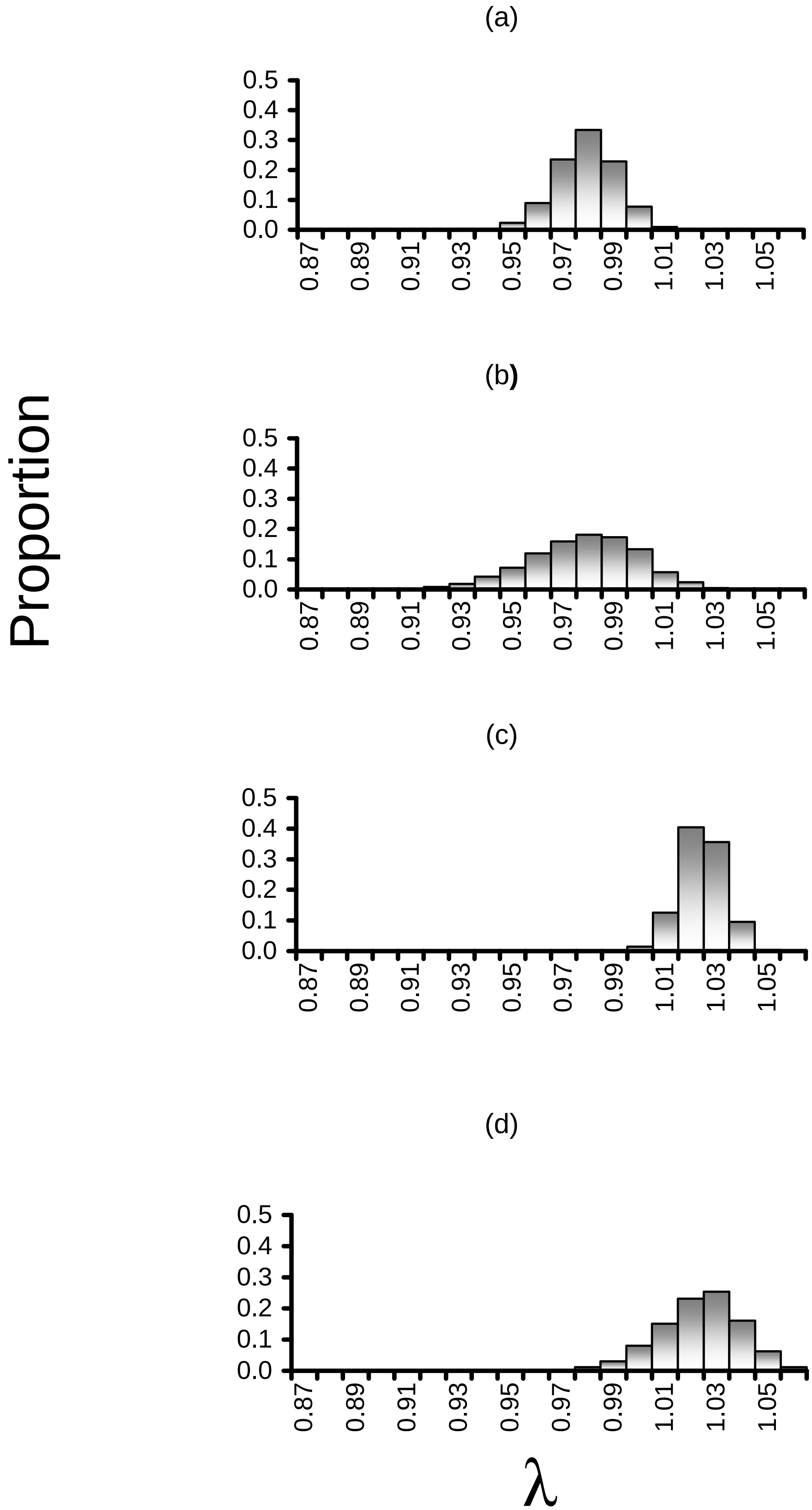


Figure 22. Selected probability distributions of λ generated by the stochastic simulation of Greater Yellowstone Ecosystem grizzly bear populations over 10 years. a. Mean independent female survival 0.87, low process variation. b. Mean independent female survival 0.87, high process variation. c. Mean independent female survival 0.92, low process variation. d. Mean independent female survival 0.92, high process variation. In each case, *n* (iterations) = 3,000.

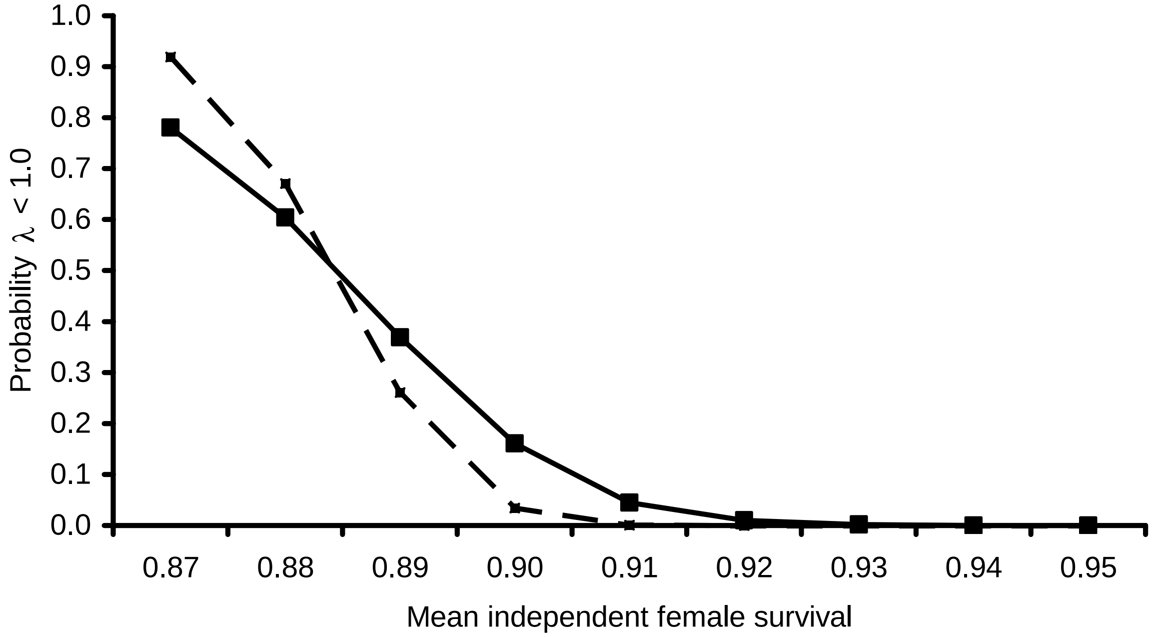


Figure 23. Probability of a decline ($\lambda < 1.0$) of the entire Greater Yellowstone Ecosystem grizzly population within 10 years as a function of independent female survival, given mean reproductive characteristics, cub survival, and yearling survival estimated during 1983–2002. Two levels of simulated yearly variance (low, dashed line; high, solid line) corresponded to the process variance resulting from treating bears with unresolved fates as censored and dead, respectively. Values at each level of independent female survival were produced by 3,000 iterations.

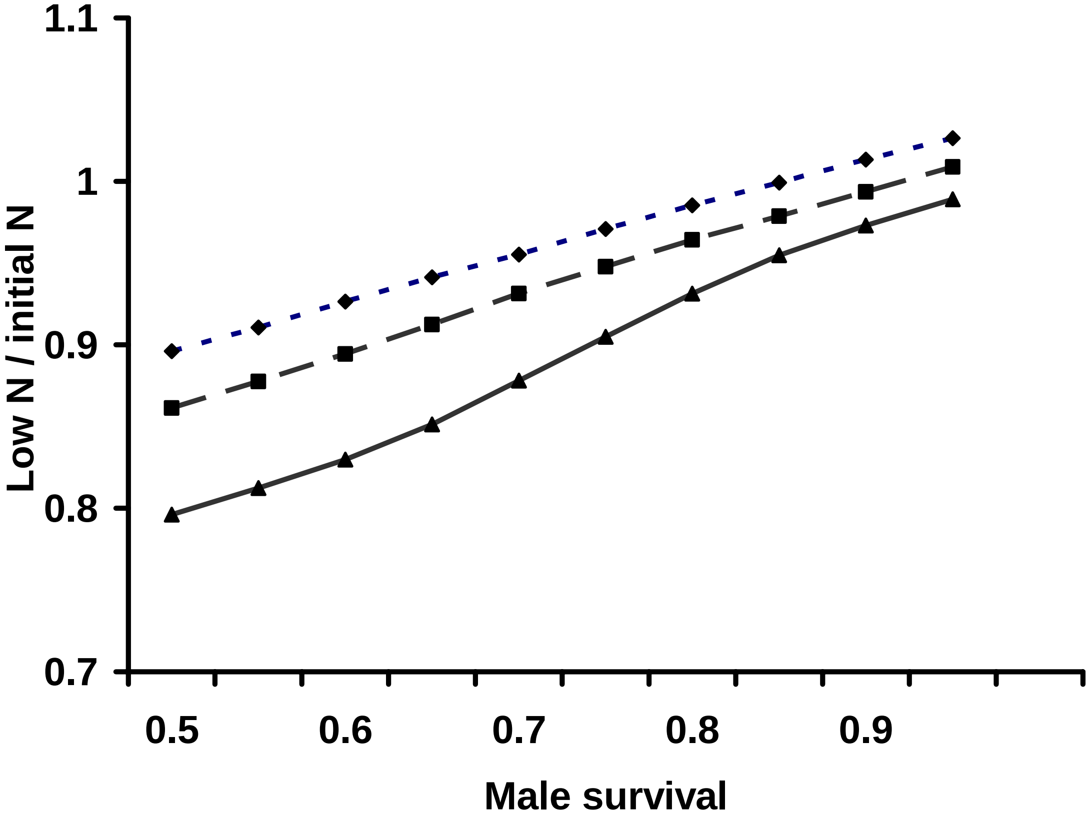


Figure 24. Mean short-term (<8 years) total population size as a proportion of initial population size of simulated grizzly bear populations in the Greater Yellowstone Ecosystem under various female (solid line 0.87; dashed line 0.92; dotted line 0.95) and male survival rates. In all cases, λ during years 6–15 conformed to those from Table 20.

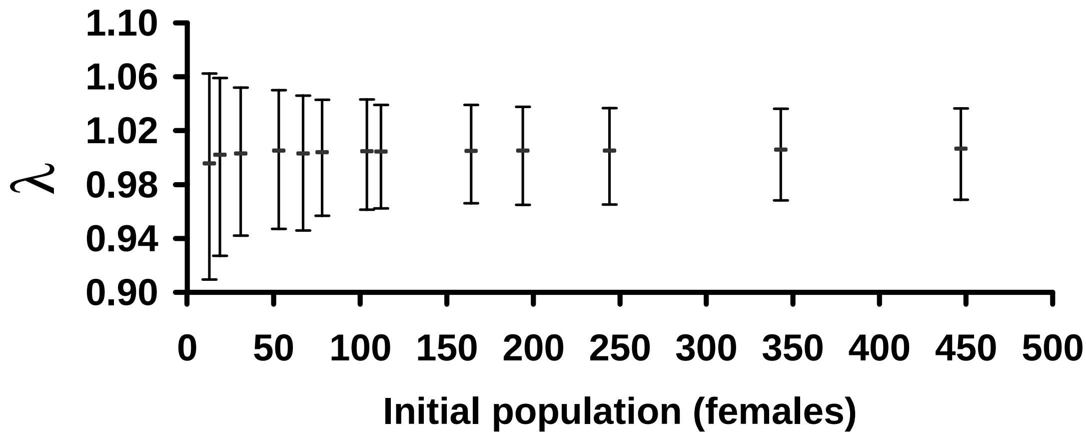


Figure 25. Mean, 2.5 percentile, and 97.5 percentile of λ for simulated Greater Yellowstone Ecosystem grizzly bear populations with mean independent female survival of 0.89, beginning at various number of female bears in the population, showing the increasing influence of demographic stochasticity at smaller population sizes. Third point from the right (at 244) shows the initial population size (females) used in all other projections. Each bar is based on 3,000 iterations with identical life history parameters except initial population size.

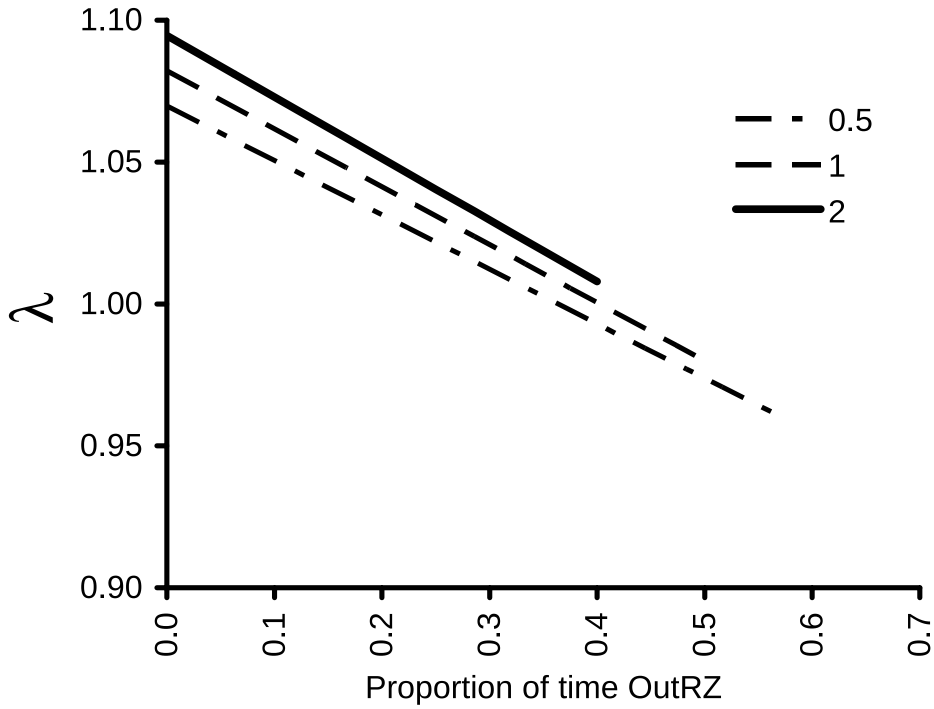


Figure 26. Short-term growth rate (λ) of the entire Greater Yellowstone Ecosystem (GYE) grizzly bear population under various assumptions regarding the proportion living within Yellowstone National Park (InYNP), within the Recovery Zone (RZ) but outside YNP (OutYNP), and beyond the RZ (OutRZ). Lines represent the ratio of bears OutYNP:InYNP. In the GYE, the ratio of area OutYNP:InYNP is approximately 1.7. The distribution of residency for our telemetry sample was 0.472, 0.393, and 0.135 for OutYNP, InYNP (area ratio = 1.2), and OutRZ, respectively.

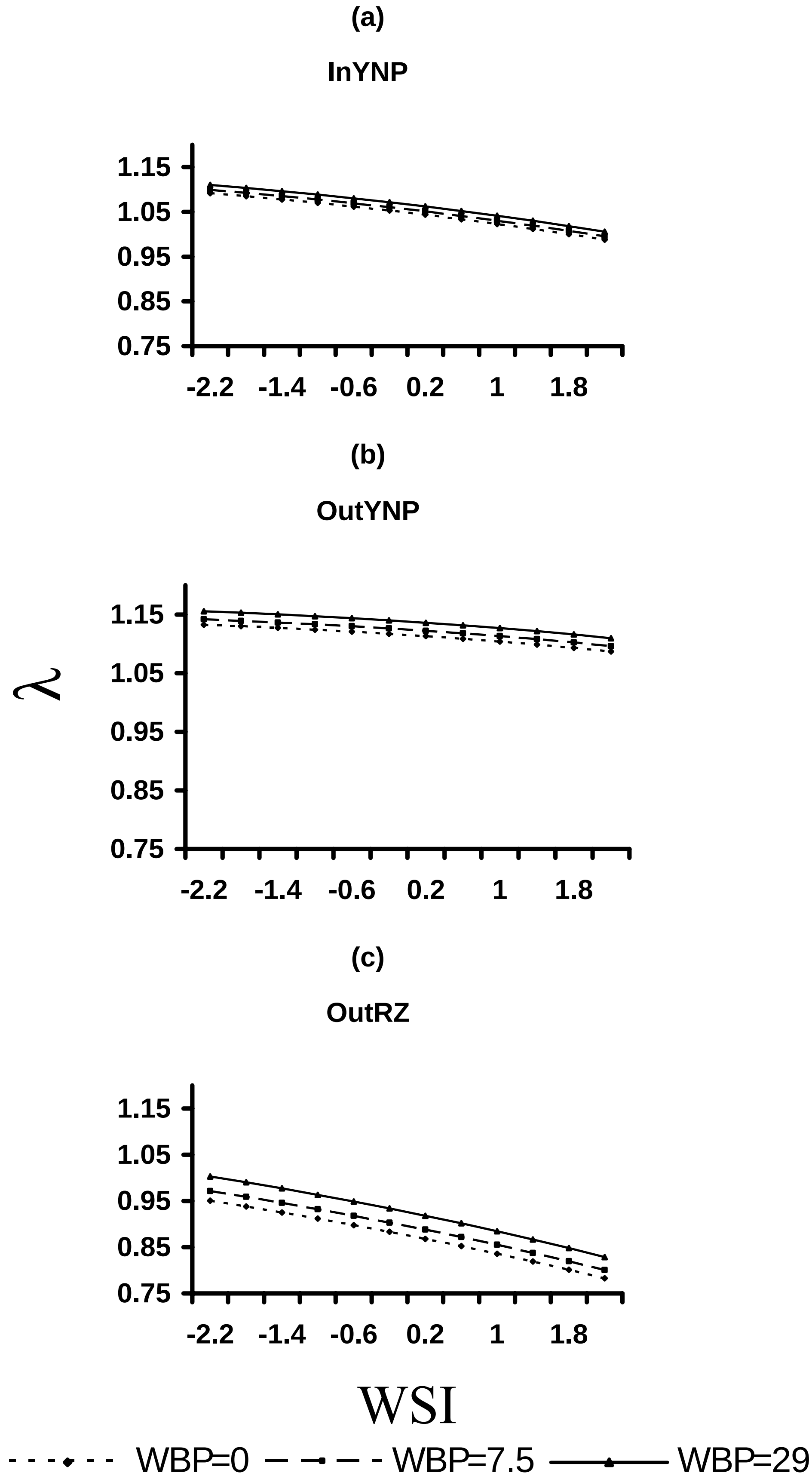


Figure 27. Population growth rate λ for hypothetical grizzly bear populations with residency (a) inside Yellowstone National Park (InYNP), (b) within the Grizzly Bear Recovery Zone (RZ) but outside YNP (OutYNP), and (c) outside the RZ (OutRZ) over the observed range of our winter severity index (WSI), with whitebark pine (WBP) cone counts represented by the low (0), mean (7.5), and maximum (29) counts observed in Greater Yellowstone Ecosytem during the study, 1983–2002.